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# UTILITY PATENT APPLICATION TRANSMITTAL

Attorney Docket No. 343355600011  
First Inventor or Application Identifier Chu, et al.  
Title Model Repository  
Express Mail Label No. EL486352351US

## APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

- ☒ \* Fee Transmittal Form (e.g., PTO/SB/17)  
(Submit an original and a duplicate for fee processing)
- ☒ Specification [Total Pages 43]  
(preferred arrangement set forth below)
  - Descriptive title of the invention
  - Cross References to Related Applications
  - Statement Regarding Fed sponsored R & D
  - Reference to Microfiche Appendix
  - Background of the invention
  - Brief Summary of the invention
  - Brief Description of the Drawings (if filed)
  - Detailed Description
  - Claim(s)
  - Abstract of the Disclosure
- ☒ Drawing(s) (35 U.S.C. 113) [Total Sheets 10]
- Oath or Declaration [Total Pages]
  - ☐ Newly executed (original or copy)
  - ☐ Copy from a prior application (37 C.F.R. § 1.63(d))  
(for continuation/divisional with Box 16 completed)
    - ☐ DELETION OF INVENTOR(S)  
Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).

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- ☐ Microfiche Computer Program (Appendix)
- Nucleotide and/or Amino Acid Sequence Submission  
(if applicable, all necessary)
  - ☐ Computer Readable Copy
  - ☐ Paper Copy (identical to computer copy)
  - ☐ Statement verifying identity of above copies

## ACCOMPANYING APPLICATION PARTS

- ☐ Assignment Papers (cover sheet & document(s))
- ☐ 37 C.F.R. § 3.73(b) Statement of Power of Attorney  
(when there is an assignee)
- ☐ English Translation Document (if applicable)
- ☐ Information Disclosure Statement (IDS)/PTO-1449 [Copies of IDS Citations]
- ☐ Preliminary Amendment
- ☒ Return Receipt Postcard (MPEP 503)  
(Should be specifically itemized)
- ☐ \* Small Entity Statement(s) [Statement filed in prior application. Status still proper and desired (PTO/SB/09-12)]
- ☐ Certified Copy of Priority Document(s)  
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16. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment:

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No: \_\_\_\_\_

Prior application information: Examiner \_\_\_\_\_ Group / Art Unit: \_\_\_\_\_

For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

## 17. CORRESPONDENCE ADDRESS

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Signature	<i>John V. Biernacki</i>	Date	09/22/00

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## for FY 2000

Patent fees are subject to annual revision.  
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See 37 C.F.R. §§ 1.27 and 1.28.

**TOTAL AMOUNT OF PAYMENT** (\$)**1614**

### Complete if Known

Application Number	
Filing Date	
First Named Inventor	Chu, et al.
Examiner Name	
Group / Art Unit	
Attorney Docket No.	343355600011

### METHOD OF PAYMENT (check one)

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Deposit Account Name **Jones, Day, Reavis & Pogue**

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2. ☐ Payment Enclosed:  
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### FEE CALCULATION

#### 1. BASIC FILING FEE

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code (\$)	Fee Code (\$)	Fee Code (\$)	Fee Code (\$)		
101	690	201	345	Utility filing fee	690
106	310	206	155	Design filing fee	
107	480	207	240	Plant filing fee	
108	690	208	345	Reissue filing fee	
114	150	214	75	Provisional filing fee	

**SUBTOTAL (1)** (\$)**690**

#### 2. EXTRA CLAIM FEES

Total Claims		Extra Claims		Fee from below		Fee Paid	
67	-20**	47	x	18	=	846	
4	-3**	1	x	78	=	78	
Multiple Dependent		0	x	0	=	0	

\*\*or number previously paid, if greater; For Reissues, see below

Large Entity		Small Entity		Fee Description
Fee Code (\$)	Fee Code (\$)	Fee Code (\$)	Fee Code (\$)	
103	18	203	9	Claims in excess of 20
102	78	202	39	Independent claims in excess of 3
104	260	204	130	Multiple dependent claim, if not paid
109	78	209	39	** Reissue independent claims over original patent
110	18	210	9	** Reissue claims in excess of 20 and over original patent

**SUBTOTAL (2)** (\$)**924**

### FEE CALCULATION (continued)


#### 3. ADDITIONAL FEES

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code (\$)	Fee Code (\$)	Fee Code (\$)	Fee Code (\$)		
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provisional filing fee or cover sheet.	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	215	55	Extension for reply within first month	
116	380	216	190	Extension for reply within second month	
117	870	217	435	Extension for reply within third month	
118	1,360	218	680	Extension for reply within fourth month	
128	1,850	228	925	Extension for reply within fifth month	
119	300	219	150	Notice of Appeal	
120	300	220	150	Filing a brief in support of an appeal	
121	260	221	130	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive - unavoidable	
141	1,210	241	605	Petition to revive - unintentional	
142	1,210	242	605	Utility issue fee (or reissue)	
143	430	243	215	Design issue fee	
144	580	244	290	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Petitions related to provisional applications	
126	240	126	240	Submission of Information Disclosure Stmt	
581	40	581	40	Recording each patent assignment per property (times number of properties)	
146	690	246	345	Filing a submission after final rejection (37 CFR § 1.129(a))	
149	690	249	345	For each additional invention to be examined (37 CFR § 1.129(b))	
Other fee (specify) _____					
Other fee (specify) _____					

\* Reduced by Basic Filing Fee Paid

**SUBTOTAL (3)** (\$)

### SUBMITTED BY

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Signature				Date	09/22/00

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Title of the Invention

**Model Repository**

Inventors

Robert Chu

Susan Tideman

## Model Repository

### BACKGROUND

#### 1. Technical Field

The present invention is directed to the fields of data warehousing, data mining, and data  
5 modeling. More specifically, the present invention provides a model repository for use in  
creating, storing, organizing, locating, and managing a plurality of data models.

#### 2. Description of the Related Art

Modern business enterprises generate large amounts of data concerning the operation and  
performance of their businesses. This data is typically stored within a large data warehouse, or  
10 some other large database infrastructure. Business analysts then review this voluminous data in  
order to make business recommendations. The data may be analyzed manually, in order to  
develop an intuition about the data, or to pick up patterns in the data, or it may be analyzed using  
statistical software to determine trends, clusters of data, etc.

More recently, with the explosion of Internet-related traffic, business enterprises are  
15 generating volumes of data that are one or more orders of magnitude larger than before. This  
increase in scale has made it almost impossible to develop an intuition about the data or to pick  
up patterns in the data by simply examining the data in its original form. Similarly, this increase  
in scale has made it difficult to manually execute separate statistical analyses on the data.

As a result of this data explosion, data mining software has been developed. A data  
20 mining software application can search through the large volumes of data stored in the data  
warehouse and can identify patterns in the data using a variety of pattern-finding algorithms.  
These patterns are then used by the business analyst in order to make business recommendations.

An example of such a data mining tool is Enterprise Miner™, available from SAS Institute, Inc., of Cary, North Carolina.

Each run of the data mining software is based on a specification. Part of the specification indicates which input data to use from the data warehouse. Another part of the specification  
5 activates one or more of the pattern-finding algorithms that are built into the data mining software. Other parts of the specification specify how to partition the data, how to assess the results, etc.

When the data mining tool is executed according to a particular specification, it generates a resulting analysis that is termed a model. The model contains information regarding the  
10 specification used for the run, including the name and location of the data set in the data warehouse that was analyzed, and also contains the resulting analysis, including any patterns that may have been detected in the data set. The model may also contain information regarding how well the pattern represents the analyzed data.

Over time, an enterprise having such a data mining tool may generate a multitude of  
15 different models, based on different input data, different data sampling techniques, different data partitions, different data mining algorithms, different assessment methods, etc. Not all of these models are useful, however. For example, some of the models may be better than others at predicting a particular outcome. Some of the models may be out of date. And some may not provide any useful results at all, or may not be able to predict any patterns in the data.

20 Typically, each person who generates models (*i.e.*, a model creator) manually keeps track of his or her own collection of models. Thus, models are scattered around the enterprise -- wherever anyone who is generating models happens to reside. There is no straightforward way for people who want to use models to know which ones (other than their own) are available and

to find the one(s) appropriate for a given purpose. Tracking down or duplicating the generation of appropriate model(s) requires extensive human resources and time.

Thus, a problem with these types of data mining systems is the inability to effectively manage the multitude of data models that are generated, and the corresponding inability to distinguish useful models from those that have limited utility. This problem is amplified when the models are generated and used by a large number of users. If the models are generated and used by only one person, or a handful of persons, then the person (or persons) generally has a good idea of which models are available and may also have a cheat-sheet for which model is associated with certain specifications, patterns, or other results. When a large number of persons are generating models, however, each model generator (or creator) would have less of a sense of which models are available, and which ones are useful. In this latter situation, a particular model creator could duplicate much of the work that may have already been done by another model creator because he or she did not know that the model, or something very close to it, had already been developed by the other model creator. In addition, people that use the models, but do not necessarily create them, typically have no idea which models are useful, up to date, or otherwise applicable to a particular analysis, or would yield a particular result.

Thus, there remains a general need in this field for a system and method for creating, storing, organizing, locating and managing a plurality of models generated by a data mining application or other application.

## SUMMARY

A model repository is provided for storing models generated by a data mining application or other application. The model repository is a structure that may be organized into a plurality of

levels, including a project level, a diagram level, and a model level. The project level may include one or more diagrams, each of which describes a particular set of model specifications. Each diagram may then be associated with one or more models. Associated with the model repository is a model repository facility that is preferably integrated into the data mining application and enables operations, such as the exportation of useful models to the model repository. The model repository may also include one or more index data structures for storing attributes of the models within the model repository. These indexes may include a main index that describes the attributes of all the models stored in the model repository, and one or more special indexes, such as a tree-type index and mini-index, that describe the attributes of a particular sub-set of the models stored in the model repository. A user may then search through the one or more indexes in order to find a model that suits his or her needs. Alternatively, a user application program may automatically query the model repository in order to find and extract information from a particular model stored in the model repository.

According to one aspect of the present invention, a model repository system is provided that includes: (1) a data structure for storing a plurality of data records; (2) a data mining application for analyzing the data records and for generating a plurality of data models; and (3) a model repository for storing the data models, wherein the model repository includes one or more index structures containing a plurality of attributes that describe the data models.

According to another aspect of the present invention, a data modeling method is provided. This method includes the following steps: (a) generating a plurality of data models using a data mining application; (b) storing the plurality of generated data models in a database associated with the data mining application; (c) selecting one or more of the plurality of generated data models; (d) exporting the selected data models from the database to a model

repository; and (e) generating one or more indexes of the data models stored in the model repository based upon a plurality of attributes associated with each of the selected data models.

Still another aspect of the present invention provides a data modeling method, comprising the steps of: (i) associating one or more attributes with each of a plurality of data models; (ii) exporting selected data models to a model repository; (iii) generating one or more index structures comprising the one or more attributes of each of the data models in the model repository; and (iv) providing a search mechanism and a retrieval mechanism for searching the one or more index structures in order to retrieve one or more data models from the model repository.

It should be noted that these are just some of the many aspects of the present invention. Other aspects not specified will become apparent upon reading the detailed description of the preferred embodiment set forth below.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a system diagram showing a preferred implementation of a model repository for use with a data mining application;

FIG. 2 is a diagram showing a preferred structure for storing models within the model repository;

FIG. 3 is a preferred data structure for a main index that is part of the model repository shown in FIG. 1;

FIG. 4 is a preferred data structure for a tree-type index that is part of the model repository shown in FIG. 1;

FIG. 5 is an alternative data structure for the tree-type index that is part of the model



repository shown in FIG. 1;

FIG. 6 is a preferred structure for a mini-index that is part of the model repository shown in FIG. 1;

FIGS. 7A-7C are flow charts showing a preferred series of steps for exporting a model to the model repository shown in FIG. 1; and

FIGS. 8A-8C are flow charts showing a preferred series of steps for generating the main index and the tree-type index that are part of the model repository shown in FIG. 1.

#### DETAILED DESCRIPTION OF THE DRAWINGS

Turning now to the drawings, FIG. 1 is a system diagram 10 showing a preferred implementation of a model repository 24 for use with a data mining application 18. The data mining application may be, for example, Enterprise Miner™, from SAS Institute, Inc. of Cary, North Carolina. Alternatively, other types of data mining programs could also be utilized with the model repository 24. The preferred implementation of a model repository is a folder. The data mining application 18 preferably includes an integrated model repository facility (MRF) application 18A, which, as described in more detail below, controls the exportation of models to the model repository 24, and the construction of one or more model indexes 26, 28, and 30. Alternatively, however, the MRF 18A could be a stand-alone application, in which case it would not be integrated into the data mining application 18.

The data mining application 18 analyzes data records stored in a data warehouse 32, or some other form of data storage facility. Although a single data warehouse 32 is shown in FIG. 1 for storing the data records, the data analyzed by the data mining application 18 could be spread out among numerous data warehouses 32 or numerous other database systems.

As described above, the data mining application 18 is executed using a particular model specification. This model specification typically indicates which input data to analyze from the data warehouse 32, which pattern-finding algorithm (such as a neural network, decision tree, etc.) to use for the analysis, how to partition the data, how to assess the results from the analysis, etc.

5 The resulting analysis that is generated by the data mining application 18 when executed according to the specification is the model.

A data model, as generated, is a set of attributes related to the run of a data mining application or another type of statistical-related software application. For example, the attributes include the location of the input data, the scoring code, the fit statistics, and so on. However, it should be understood that data models can be generated by applications other than a data mining application, such as by a statistical modeling software application.

The models 22A, 22B, 22C that are generated by the data mining application 18 are initially stored in individual project folders 20. For example, each model creator 12 may have his or her own project folder stored in a database of project folders 20. The model creators 12 would then store their own models 22A, 22B, 22C in their individual project folders.

Using the model repository facility 18A, certain useful ones of the generated models 22A, 22B, or 22C can be selected and exported into the model repository 24. These useful models can then be searched for and retrieved manually by end-users 16, or programmatically by end-user applications 16. As described in more detail with reference to FIG. 2, the models 23A, 23B, 23N2 stored in the model repository 24 are organized according to a plurality of logical levels, including a project level, a diagram level, and a model level. The project level may include one or more diagrams, each of which describes a particular set of model specifications. Each diagram at the diagram level may then be associated with one or more individual models at the

model level.

With reference back to FIG. 1, for each level of the model repository structure, one or more additional descriptive attributes may be associated with the models. The attributes provide descriptive information about the model that can be used to identify a particular model in the model repository 24 via a search and retrieval process. These attributes may be automatically associated with the models by the data mining application 18, or by the model repository facility 18A when the model is exported to the model repository 24. In addition, any of the system users 12, 14, 16 may associate additional attributes with the models. The model attributes may be assigned at the project level, the diagram level, or at the individual model level.

These model attributes are then organized and structured into one or more indexes 26, 28, 30, which are also stored in the model repository 24. These indexes may include a main type index 26, which includes some or all of the attributes for each of the models 23A, 23B and 23N2 in the model repository 24, and/or may include one or more special indexes, such as a tree-type index 28, which includes the attributes for a sub-set of all the models stored in the model repository 24. For example, the tree-type index 28 would include certain attributes of those models that were generated using a decision-tree algorithm. The decision-tree algorithm generates a type of attribute known as splitting variables, which are stored in the tree-type index 28. Also shown in FIG. 1 is a mini-index 30, which provides a quick-search capability for the tree-type index 28. These various indexes are used by end users 16, or by end user applications 16, in order to find a particular model, or set of models, within the model repository by executing a search and retrieval operation on the attributes stored in the indexes 26, 28, 30.

A variety of system users can interact with the data mining application 18 and the model repository 24, including a model creator 12, a model repository administrator 14, and an end-user

16. The model creator 12 is the person who operates the data mining application 18 in order to generate a particular model. The model creator 12 determines the specifications for a particular data mining run, generates the corresponding model based on the specification, and then stores the model in his or her individual project folder 20. Alternatively, the model creator 12 could take an existing model from one of the project folders 20, modify the specification in some manner, and then generate a new model. Moreover, because the data in the data warehouse 32 typically changes over time, a model creator 12 can use the same specification against a later version of the data to generate a new model based on the updated data. The model creator 12 may then utilize the MRF 18A to export certain useful models to the model repository 24.

The model repository administrator 14 performs a variety of functions. One of these functions is to control access to the model repository 24. This may include controlling access rights to certain users, such as read access rights and write access rights. In this manner, the model repository administrator 14 can control which users can add or over-write models in the model repository (those having write access) and which users can only read models (those having only read access). The model repository administrator 14 may also control the process of deleting models from the model repository. Control of model deletion is important to ensure that a user with write access does not inadvertently delete a useful model from the model repository 24. In addition, the model repository administrator 14 may also determine which model attributes will be included in the main index 26.

The end-user 16 is the person who is interested in using the models in the model repository 24. The end-user 16 could also be a model creator 12, although not all end-users will be creating models. The end-user 16 accesses the model repository 24 and searches for an appropriate model 23A, 23B, 23N2 by examining the one or more index structures 26, 28, 30.

By supplying search parameters and then comparing these search parameters against the attributes stored in the index structures, the end-user 16 is able to find one or more useful models. Having found a useful model, the end-user 16 may then obtain a copy of the information contained in the model. A special graphical user interface could be provided to the end-user 16 in order to facilitate the search and retrieval process with the model repository 24. The graphical user interface can be used to send a search and/or retrieval request to the model repository 24 over a network, such as a local, wide area, or global (e.g., Internet) network.

The end-user 16 may also be an end-user application program that programmatically searches for and retrieves an appropriate model from the model repository 24. The end-user application program can send a search and/or retrieval request to the model repository 24 over a network, such as a local, wide area, or global (e.g., Internet) network. This search and retrieval capability makes it possible to automate the deployment of models for specific purposes. For example, suppose that part of the operation of an application requires that it find a "best" model (perhaps based on the one with the best assessment results). Or suppose that part of the operation requires it to choose a model from many similar ones (perhaps based on the one that was most recently generated from certain input data). That part of the operation can be accomplished automatically using the indexes 26, 28, 30 to find the one or more models 23, and then by employing some type of comparison algorithm in order to determine which model is most suitable for the particular task. For example, the comparison algorithm could look for the model with the lowest rate of misclassification. The ability to search for a model or models programmatically is particularly important in real-time applications, such as web-based applications, because a person could not find the appropriate model or models fast enough to suit

the real-time nature of the task . The selected model then could be used by the end user 16, for example to generate scored data 34.

In addition, with the appropriate access level, an end-user 16 could from time-to-time make a copy of the index(es) 26, 28, 30 and modify them in order to improve performance. Search and retrieval performance on the indexes would be improved because the modified copies would be stored locally to the end-user, and because the copies could contain only the rows and columns of the index structure needed for his or her purpose. In this manner, each end-user 16 could maintain his or her own index structures for the model repository 24.

Although a single model repository 24 is shown in FIG. 1, this is just one example of a system 10 employing the invention. Alternatively, a particular business enterprise may have more than one model repository 24. In addition, a given model repository 24 may have more than one main-type index 26, or more than one special-type indexes 28, 30. For example, the marketing group of a particular business could have their own main index structure 26 that is based on the model attributes that matter for their purposes, and the sales group could have their own main index structure 26 that is based on other model attributes that matter for their purposes. Although a particular model repository 24 may have more than one special-type index 28, it is preferable that for the particular type of special-type index, such as the tree-type index 28 and mini-index 30, there would be only one of that type of index for each model repository 24.

FIG. 2 is a diagram showing a preferred structure for storing models within the model repository 24. According to this preferred structure, the model repository 24 is organized into three levels, the project level 300, the diagram level 302, and the model level 304. Each project, for example Project A, at the project level 300, may refer to one or more diagrams at the diagram level 302. Each diagram, such as Diagram 1, may then refer to one or more individual models at

the model level 304.

Using this structure, multiple data mining projects can be associated with the same model repository 24, multiple data mining diagrams can be associated with the same project, and multiple models can be associated with the same diagram. A diagram represents the specifications for a data mining run. There are typically groups of specifications, such as those related to the input data, the sampling technique, the data partitions, the data mining algorithm, the assessment methods, etc. More than one model may be associated with each of these diagrams. For example, although the specification may be the same for two models, there may be some attribute of the models that is different, such as when the model was run, that will result in a different model based on the same specification.

The first time that a request is received by the MRF 18A to export a model to the model repository 24 for a given project, a folder is created at the project level 300 for that project. The name of the project-level folder preferably identifies the current date and time and the last three characters of the requestor's user identification. For example if the current time was 19May2000:16:15:40 and the model export request was made by a person with the user identification "abc," then the name of the new project-level folder would be "2000\_05\_19\_16\_15\_40\_abc\_project". Note, however, that this is just one way to determine the name for the project-level folders, and other methods could certainly be utilized.

The first time that a diagram is encountered within a particular project, the diagram is given a sequential number, such as 000, 001, 002, 003, . . . , etc. For a given diagram, there could be multiple models. For example, suppose the input data is sales records. If the diagram is used once a month, there will be one model each month. If every month's model is worth saving, every month the model repository 24 receives an additional model that is associated with that

diagram of that project. Within a given project and diagram, there is thus a one-to-many relationship between the diagram and its models (and between the project and its diagrams).

The name of the model's folder preferably identifies the diagram with which the model is associated (*i.e.*, 000, 001, 002, 003, . . . , etc.) and also preferably identifies the model itself.

5 Each model preferably has a model-identification that is unique within the diagram and unique within the project.

The above description sets forth the coarse organization of the model repository 24. The coarse organization is provided by project-id, diagram-number, and model-id. Although these identifiers provide a useful way to identify a model, a general search is likely to require a finer level of granularity. In order to provide this finer level of granularity, the present invention introduces the concept of model attributes. Some attributes are automatically generated and associated with the models in the project folder 20 by the data mining application 18. If permitted by the export-results option, these attributes are associated with the models in the model repository 24 by the model repository facility 18A. The MRF 18A also generates attributes that it associates with the models in the model repository 24.

Model descriptors are additional attributes that are associated with the models in the model repository 24, and also may be used in the main index 26, which can be searched by a user in order to find and retrieve a particular model 23 or set of models. Descriptors can be assigned at the project level, the diagram level, and/or at the model level. Descriptors can be manually associated with the models in the project folder 20 by any of the system users 12, 14, 16. A descriptor preferably includes a variable-value pair, such as "site=Chicago" or "size=100,000". In these examples, site is a variable and Chicago is its value, and size is a variable and 100,000 is its value. The variable-value pairs may be manually specified by one of the system users 12, 14,



16 via a graphical user interface element, such as a pop-up window, notes tab, or other graphical data entry means, for selecting the particular project, diagram or model, and then for entering the appropriate descriptor.

As a result of these levels of attributes, a given model is identified by its own attributes, the attributes of its diagram, and the attributes of the diagram's project. By storing and organizing these model attributes in the various index structures 26, 28, 30 of the model repository 24, a much finer granularity for searching is provided.

FIG. 3 is a preferred data structure for a main-type index 26 that is part of the model repository 24 shown in FIG. 1. The main-type index 26 is structured as a table. The table includes a first column 40 in which the model is identified, and a plurality of other columns 42A, 42B, . . . , 42N, in which a plurality of attributes are specified. If the model's identification is not unique within the model repository, then an additional column is used to identify the project for which the model was generated. As noted above, each attribute is specified by a variable-value pair. The variables are listed in the first row of the table as Attribute A1, Attribute A2, Attribute A3, . . . , Attribute M1. The values for a given model are then set forth in the cells of the table for the row that is identified by the particular model's identification (and project identification, if necessary). The model names 44 preferably include an initial numerical identifier, such as "000" or "001", which identifies the diagram with which the particular model is associated.

In principle, the main-type index 26 could be constructed using the variables for every attribute associated with the models stored in the model repository 24. For practical reasons, however, the model repository administrator 14 preferably selects a subset of the attributes in order to construct the index, where the subset represents the attributes that end-users 16 most likely would utilize in order to conduct a search. Preferably, in the model repository's

configuration subfolder, the model repository administrator 14 lists in the columns Info\_user.text file the subset of human-defined descriptors that are to be used in the main index, and in the Columns Info\_system.text file the subset of data-mining-application-defined attributes that are to be used in the main index. In addition, the model repository administrator 14 could decide to build more than one main-type index 26 for the model repository 24. Having more than one main index 26 would be useful if the search strategies employed by users can be grouped into several categories. In this situation, there could be one main-type index 26 per search category, with the attributes in that index being the ones that are useful in that category of search.

FIG. 4 is one of two preferred data structures 28A and 28B for a tree-type index 28 that is part of the model repository 24 shown in FIG. 1. Like the main-type index 26, the tree-type index 28A is organized as a table. The first column of the table 50 identifies the model 54. If the model's identification is not unique within the model repository, then an additional column is used to identify the project for which the model was generated. The remaining columns 52A, 52B, 52C, . . . , 52N set forth a plurality of attributes that are specific to the models associated with the tree-type index. These models were generated using a decision tree algorithm in the data mining application 18. For the tree-type index 28A, these special attributes are called the splitting variables. The intersection of a row and column in the tree-type index 28A is a cell that indicates whether or not (Yes or No, 1 or 0) a particular splitting variable is used in a particular model.

A model that results from a decision tree analysis identifies the variables that enable groups to be identified within the data. The records/observations within a group have similar behavior with respect to a target variable. For example, in a sales analysis, the target variable might be the one that contains the total amount of the sale. The variables that define the groups

in the decision tree analysis are called predictor variables. The predictor variables that are most important to the analysis are called the splitting variables. It is these splitting variables that are listed in the tree-type index 28. The other predictor variables describe splits that are too trivial to matter to the outcome of the analysis.

5           The tree-type index 28A is preferably constructed using every splitting variable in the model repository 24. There are preferably two formats for the tree-type index 28. The format that is most comfortable for people to work with (such as, index 28A), if browsing the index, may or may not be the format that gives the best performance (such as, index 28B) to an application that may be automatically searching for and retrieving models from the model repository 24.

10           The first format 28A is shown in FIG. 4, as described above. The second format 28B is a table that has as many rows per model as the model has splitting variables. This second format 28B is shown in FIG. 5, and includes two columns, a first column 60 that identifies the model, and a second column 62 that identifies the splitting variable. If the model's identification is not unique within the model repository, then an additional column is used to identify the project for which the model was generated. In this second format, if a model has four splitting variables, then the model has four rows in the table.

15           If the number of rows in the tree-type index 28 becomes too large for efficient searching, then an additional mini-index 30 can be provided in the model repository 24. The mini-index 30 contains a list of the names of all the splitting variables in all the models. In the mini-index 30, each splitting variable name appears only once. In the tree-type index 28, each splitting variable name may appear many times. Thus, the mini-index 30 is an index to the tree-type index 28. If

the mini-index 30 is searched first, and the splitting variable that is needed is not there, then there is no need to search the tree-type index 28, thus making the search process more efficient.

FIG. 6 is a preferred data structure for a mini-index 30 that is part of the model repository 24 shown in FIG. 1. The mini-index is a table. The table includes one column, which identifies the name of a splitting variable that is in at least one of the models in the model repository.

FIGS. 7A-7C are flow charts showing a preferred series of steps for exporting a model to the model repository 24 shown in FIG. 1. As noted above, these model exportation steps 100-180 are preferably carried out by the model repository facility 18A that is integrated into the data mining application 18.

The model exportation process begins at 100. At step 101, a model creator 12 creates one or more data mining models using the data mining application 18. These models 22A, 22B, 22C are then stored in one or more project folders 20 associated with the data mining application 18. Typically, each model creator 12 has his or her own folder, or set of folders, where he or she stores models he or she has created. The project folder has a name, which may or may not be unique. If a model has been exported from the folder, the project also has an identification that is unique. Having created a model, or set of models, the model creator 12 may then add model descriptor attributes to the models at step 102. These model attributes can be associated with the models at one or more of the levels defined in the structure of the model repository 24.

In a preferred embodiment, the model repository 24 is structured into three levels, the project level, the diagram level, and the model level. In step 102, a model creator can associate one or more model attributes with a model in the project folder 20 at any of these levels. Note also that the data mining application 18, or, alternatively, the model repository facility 18A, may also associate various attributes with the models at each of the various structural levels. In this

manner, there are automatic attributes, which are associated by the system software, and manual attributes, which are associated by one or more of the system users.

At step 104, the user then compares models stored in the project folder 20 in order to identify a particular model to export to the model repository 24. The user then selects a particular model at step 106. Having selected the model to export, at step 108 the user then specifies the pathname of the model repository 24 to which the selected model is to be exported. This step is needed when the MRF 18A includes more than one model repository 24. In this case, the user needs to supply an address, or pathname, of the particular model repository 24.

Once the pathname is selected, the user then clicks on an export button at step 110. The export button is preferably a graphical user interface element that is integrated into the MRF 18A in order to instruct the MRF 18A to proceed with the exportation process. Alternatively, the export function could be initiated from a pull-down menu or via some other software selection process. After the user selects the export button at step 110, the MRF 18A then checks whether this particular user has the appropriate access rights to the model repository 24 that was specified via the pathname. As described above, the model repository administrator 14 controls access rights (both read and write) to the model repository 24 in order to ensure that only authorized users can access and operate the system. Thus, at step 114, the MRF 18A determines whether this user has write access rights to the selected model repository 24. If the user does have write access rights, then control passes to step 118, and the export process continues. If, however, the user does not have the appropriate access rights, then control passes to step 116 and a “lack-of-write-access” message is displayed to the user indicating that the user is not able to export models to the selected model repository 24. From step 116, control reverts back to step 108, and the user is then presented with the opportunity to select another model repository 24 to which he

or she may have the appropriate access rights.

Assuming that the user does have the appropriate access rights, control then passes to step 118, where the MRF 18A creates an export object. The export object is preferably provided by the data mining application 18, and is a software mechanism used to move information from the model stored in a particular project folder 20 to the model repository 24. At step 120, the MRF 18A initializes the export object. At step 122, the system determines whether a configuration subfolder exists in the model repository 24. If so, then control passes to step 126. If not, however, then at step 124 the MRF 18A creates a configuration subfolder within the model repository 24, and populates this subfolder with a set of default configuration files. This step is carried out preferably only the first time that a model is exported to the model repository 24.

At step 126, the MRF 18A retrieves information from a "results-option" configuration file that is in the configuration subfolder in the model repository 24. This file instructs the MRF 18A as to what information from the model should be exported to the model repository 24. The model may contain numerous types of result information from the data mining run that are not necessary or desirable (for space reasons) to export into the model repository 24. By using this export results-option configuration file, the model repository administrator 14 can control the type and amount of model information that is exported to the model repository 24. The MRF 18A then sets the results export property of the export object at step 128. The property effectively controls the information being exported into the model repository 24 for the selected model.

Having configured the export object, at step 130 the MRF 18A obtains from the current model the diagram identification (such as "000", "001", etc.) and also the model identification, in order to generate a model folder name to be used in the model repository 24. At step 132, the

MRF 18A then obtains from the current model the project identification. If the project identification exists in the project folder 20 at step 134, then control passes to step 138. If, however, the project identification is not already part of the project folder 20, then at step 136 the MRF 18A takes the current export time and the last three characters of the user's identification and creates the project identification.

At step 138, the MRF 18A retrieves the existing, or new, project identification. The project identification is then used by the MRF 18A to extend the selected model repository 24 pathname in order to create a project folder name to be used within the model repository 24. At step 141, the MRF 18A then invokes an export method on the configured export object with the newly extended pathname including the project folder as a method argument to the export method. It is this export method that actually copies the non-descriptor model information (as permitted by the results-option configuration file) from the project folder 20 to the model repository 24.

Following this exportation step, the MRF 18A then reads (or extracts) from the project folder 20 the various attributes (also referred to herein as descriptors) for the three levels associated with the preferred model repository structure – project, diagram and model – at step 142. These attributes are typically stored in the form of “notes” that are attached (or associated) with the project, diagram, and selected model in the project folder 20. These “notes” may contain information in addition to the project, diagram, and model descriptor attributes, and thus at step 146, the MRF 18A filters the notes by eliminating all entries that do not begin with the prefix “MR:”. This prefix, “MR:”, is indicative of a descriptor attribute, and thus can be used by the MRF 18A to identify and extract all of the model's descriptor attributes from the notes. At step 148, the model descriptor attributes from the three levels are then concatenated into a single

file. This file is then saved in the model repository 24 at step 150 in the model's folder.

Each model that is exported to the model repository 24 is stored according to the preferred three-level organization shown in FIG. 2. The lowest level of organization, the model level, is a folder in which several files can be stored. The information that was exported from the model in step 141 is one such file. The concatenated attribute file from step 148 is also stored in this same model folder.

At step 152, the system determines whether this particular model was generated using a decision tree algorithm. If not, then control passes to step 158. If so, however, then at step 154, the MRF 18A converts the tree data stored in the model folder in the model repository 24 into an extensible markup language (XML) file and also saves this XML file in the model folder in the model repository 24. This conversion to XML step is carried out so that users who access the model (or applications that may access the model) can easily interpret and graphically visualize the decision tree structure that generated the model.

At step 158, the MRF 18A then obtains the current time. This information is then saved in the model folder at step 160 for later reference (*see*, steps 242 and 249 of FIGS. 8B and 8C). At step 162, the MRF 18A determines if the user desires to export another model. If so, then control reverts back to step 106, where the user selects another model to export to the model repository 24. If not, however, then control passes to step 164, and the MRF 18A determines from the user 12 whether the indexes associated with the model repository 24 should be rebuilt in order to account for the newly exported models. If the user decides not to rebuild the indexes, then the export method ends at 168.

If, however, the user desires to immediately update the indexes, then control passes to steps 165-180. At step 165, the model repository is locked. That is, no models can be exported



while the indexes are being updated. At step 166, an index-type flag is set to “main.” At step 170, an update-type flag is set to “incremental”. By setting the index-type flag to “main” and the update-type flag to “incremental,” the system will perform an incremental re-build (as opposed to a complete re-build) of the main index in step 172 in order to include the indexing information associated with the newly-exported models. The preferred build index method is further detailed below with reference to FIGS. 8A-8C.

Having incrementally updated the main index, step 174 determines whether at least one of the newly-exported models was generated using the decision tree algorithm. If not, then the export method ends at step 168. If so, however, then control passes to step 176, where the index-type flag is set to “tree.” At step 178 the build index steps (that are set forth in FIGS. 8A-8C) update the tree-type index 28 and the associated mini-index 30. At step 180, the model repository is unlocked. Control then passes to step 168 and the export method ends.

FIGS. 8A-8C are flow charts showing a preferred series of steps for generating the main index 26 and the tree-type index 28 and mini-index 30 that are part of the model repository 24 shown in FIG. 1. The method begins at step 200. At step 202, the system user, which could be the model creator 12 or the model repository administrator 14, issues a build index command. (For example, steps 172 and 178 in FIG. 7C issue this command.) In response to this command, the MRF 18A then creates a new model repository (MR) object. The MR object is used by the MRF 18A to accomplish the re-build of the particular indexes in the selected model repository 24. (For example, steps 166 and 176 in FIG. 7C request an update of a particular index.) At step 206, the system obtains the MR pathname for the model repository 24 whose indexes are to be rebuilt. Following this step, the MR object is configured to interact with the appropriate model repository 24 at step 208 by setting the pathname property of the MR object using the MR

pathname from step 206.

Control then passes to step 210, and the MRF 18A determines whether the build index command is for a complete index rebuild, or for an incremental rebuild. This determination step is accomplished by examining the update-type flag. (For example, step 170 in FIG. 7C sets that flag.) If the update-type flag is set to incremental, then control passes to step 212, otherwise control passes to step 216.

At step 212, the system determines whether the index table(s) exists in the selected model repository 24. If not, then control passes to step 214. If the index table does exist, then control passes to step 213. At step 213, the system then determines whether information regarding the last time that the index was rebuilt is present in the model repository 24. If not, then control passes to step 214, and if so, control passes to step 220.

Thus, if the index is being completely rebuilt (as determined in step 210), or if the index table does not exist in the model repository (as determined in step 213), or if the information regarding the last index rebuild time is not present (as determined in step 214), then control passes to step 214. At step 214, the system determines whether the index being updated is the main index. If so, the system obtains the lists that the model repository administrator 14 specified of the attributes that are to be used in the main index, and then control passes to step 216. At step 216, a new index table structure is created for the selected model repository 24. This new index table structure is the main-type index 26 or the tree-type index 28. From step 216, the MRF 18A then determines whether the index being updated is the tree index 28 (and thus also the mini-index 30). If so, then at step 219, the system also creates the index structure for the mini-type index 30. Control then passes to step 220.

At step 220, a new or existing index table is then opened, depending on whether the table

was just created (by following steps 214-219), or was an existing table that is going to be incrementally updated (by flowing through steps 210, 212 and 213 to step 220). At step 221, the index's most recent build time is then copied to the MR object from the configuration subfolder in the model repository 24. As noted previously, the MR object is the software structure used by the MRF 18A to rebuild the indexes in the selected model repository 24.

At step 222, the MRF 18A then creates a list of the project-level folders 300 in the selected model repository. Control passes to step 224, and the first project-level folder name is then obtained from the project-level list. Step 226 determines whether all of the project-level folders in the project-level folder list have been examined. If so, then control passes to steps 228 through 233, which complete the index building process. If not, then potentially not all of the models in the various project folders have been indexed, and control passes to steps 234 through 280, which perform the indexing function for the individual models in the model repository.

Turning now to the individual indexing process (steps 234 through 280), at step 234 the selected project-level folder name is parsed into its components. Step 236 determines whether the parsed name is actually a project folder by determining whether the name ends with the project folder designator “\_project.” If the parsed name does not end with this designator, then the name is not a project folder name, and control passes back to step 224 in order to obtain the next project-level folder name from the project-level folder list. If the parsed name does end with this designator, however, then control passes to step 238.

At step 238, a list of model-level folders within the particular project folder is then created. This list is termed the model-level folder list. At step 240, the first name in the model-level folder list is then obtained. Step 244 then determines whether all of the names associated with the selected project folder have been examined. If so, then control passes back to step 224

in order to select the next name in the project-level folder list. If there are names remaining in the model-level folder list for this particular project folder, however, then control passes to step 246.

Step 246 parses the currently selected model-level folder name. Following this step, step 248 then determines whether the parsed name is actually a model by determining whether the name ends with the model designator “\_model.” If the parsed name does not end with this designator, then the name is not a model folder name, and control passes back to step 240 in order to obtain the next name from the model-level folder list. If the parsed name does end with this designator, however, then control passes to step 249.

At step 249, the model export time is obtained. The export time was stored along with the model in steps 158 and 160 of the model exportation process detailed in FIG. 6. Step 250 of the index building method then determines whether the build is an incremental build or a full re-build. If it is not an incremental build, then control passes to step 254. If the current operation is an incremental build, however, then at step 252 the last (most recent) index build time is obtained, and at step 242 this time is then compared to the export time. If the export time of the selected model is earlier than the last index build time (meaning that this model’s attribute information has already been placed into the index structure(s)), then control passes to step 240, and the next model is selected from the model-level folder list. If the export time of the selected model is later than the last index build time (meaning that this model’s attribute information has not been placed into the index structure(s)), then control passes to step 254.

Steps 254 through 280 perform the index build operation for the individual models in the model-level folder list. At step 254, the method determines whether the index that is being updated is the main-type index 26. If so, then control passes to step 258, and if not, then control

passes to step 256. If it is not the main-type index 26 that is being updated, then at step 256, the MRF 18A determines whether the model is a decision tree model. If it is a decision tree model, then control passes to step 268, and if it is not a decision tree model or a model associated with the main index 26, then control passes back to step 240 in order to obtain the next model from the model-level folder list.

At step 258, the model descriptions (or attributes) that are associated with the selected model and permitted by the column info in step 215 are obtained from the model in the model repository 24. Step 264 then creates a new data record that includes those model attributes, the model's folder name, and the export time. At step 266, this new data record is then appended to the main-type index 26, and results in a new row in the main index table 26, as shown in FIG. 3.

At step 268, the splitting variables associated with the model are obtained from the model in the model repository 24. These splitting variables are then organized into a splitting variable list. The first splitting variable is obtained from the splitting variable list at step 270. Step 272 then determines if all the splitting variables for this model have been indexed. If so, then control passes back to step 240 to obtain the next model in the model-level folder list. If not, then at step 274 a new data record is created that includes the full pathname of the model and the selected splitting variable name from step 270. At step 276, this new data record is then appended to the tree-type index 28, and results in a new row in the tree index table, as shown in FIG. 5. Alternatively or additionally, the tree index table shown in FIG. 4 could be formed by creating a new data record that includes the full pathname of the model and an indication of which splitting variables associated with the tree-type index 28 are also present in the selected model. Following step 276, a record is created at step 278 that includes the selected splitting variable name from the splitting variable list. At step 280, this new data record is then appended to the mini-index

table 30. Control then reverts to step 270 in order to obtain the next splitting variable for the selected model.

Turning back to steps 228 through 233, these steps are executed when step 226 determines that all of the project folders in the project-level folder list have been analyzed, and the corresponding models within these project folders have been indexed according to steps 254 through 280. At step 228, the current time is saved as the index's build time in the configuration subfolder of the model repository 24. The index's table is then closed at step 229 and saved to the model repository 24. At step 230, the method determines whether the index being updated is the tree index. If not, then the index build process ends at step 233. If the index being updated is the tree index, however, then at step 231 the mini-index 30 is sorted and any duplicate splitting variable entries are removed. This removal is done because the mini-index 30 to the tree-type index 28 is used only to determine whether there is some model in the model repository 24 that includes a particular splitting variable. Thus, only one entry is needed per splitting variable in the mini-index 30, and any duplicate entries can be discarded. At step 232 the mini-index table 30 is closed and saved to the model repository 24, and at step 233 the index build method ends.

The preferred embodiment described with reference to the drawing figures is presented only to demonstrate an example of the invention. Additional, and/or alternative, embodiments of the invention would be apparent to one of ordinary skill in the art upon reading this disclosure.

**What is claimed:**

1. A model repository system, comprising:

a data store for storing a plurality of data records;

a data mining application for analyzing the data records and for generating a plurality of

5 data models; and

a model repository for storing the generated data models, wherein the model repository includes one or more index structures containing a plurality of attributes associated with the data models.

10 2. The model repository system of claim 1, further comprising:

a model repository facility for exporting the generated data models to the model repository.

15 3. The model repository system of claim 2, further comprising:

a project folder store associated with the data mining application for temporary storage of the generated data models.

4. The model repository system of claim 3, wherein data models from the generated data models are selected for exporting into the model repository, wherein the model repository facility exports  
20 the selected data models from the project folder store to the model repository.

5. The model repository system of claim 1, further comprising:

a search and retrieval interface for searching the one or more index structures in the model repository and for retrieving one or more of the data models based on the searching by the search and retrieval interface.

5 6. The model repository system of claim 5, wherein the search and retrieval interface is incorporated into a software application for automatically searching the index structures in the model repository and for retrieving one or more of the data models.

10 7. The model repository system of claim 6, wherein the software application includes a comparison algorithm for determining which of the data models of the one or more retrieved data models is the most relevant model.

15 8. The model repository system of claim 5, wherein the search and retrieval interface is a stand-alone graphical user interface for manually searching the index structures in the model repository and for retrieving one or more of the data models.

9. The model repository system of claim 1, wherein the data store is a data warehouse.

20 10. The model repository system of claim 2, wherein the model repository facility is integrated into the data mining application.

11. The model repository system of claim 2, wherein the model repository facility is a stand-alone software application.



12. The model repository system of claim 1, wherein the one or more index structures include a main index and one or more special indexes, wherein the main index includes attributes of all the data models stored in the model repository, and the one or more special indexes include attributes  
5 from a sub-set of all the models stored in the model repository.

13. The model repository system of claim 12, wherein the one or more special indexes include a tree-type index for storing attributes associated with models that are generated using a decision tree algorithm.

14. The model repository system of claim 13, further comprising a mini-index associated with the tree-type index for storing a sub-set of all the attributes stored in the tree-type index.

15. The model repository system of claim 13, wherein the attributes stored in the tree-type index include a plurality of splitting variables associated with the decision tree algorithm.

16. The model repository system of claim 1, wherein the one or more index structures are organized into attribute tables.

17. The model repository system of claim 16, wherein the attribute tables include a main attribute table for storing the main index and a tree-type table for storing the tree-type index, wherein the main and tree-type attribute tables include a plurality of rows and columns, wherein each row in the attribute tables is associated with a particular data model, and wherein each column in the

attribute tables is associated with at least one attribute, said attribute tables including a mini-index attribute table that has a plurality of rows and a column, wherein each row in the mini-index attribute table is associated with one attribute in the tree-type attribute table.

5 18. The model repository system of claim 1, wherein the model repository is organized into a plurality of storage levels.

19. The model repository system of claim 18, wherein the plurality of storage levels include a project level, a diagram level, and a model level.

10 20. The model repository system of claim 19, wherein a particular data model is stored in the model repository at the model level.

15 21. The model repository system of claim 20, wherein each model stored at the model level is associated with a particular diagram stored at the diagram level.

22. The model repository system of claim 21, wherein each diagram stored at the diagram level includes a set of specifications for operating the data mining application.

20 23. The model repository system of claim 22, wherein each diagram stored at the diagram level is associated with a particular project folder stored at the project level.

24. The model repository system of claim 19, wherein the attributes of each data model are associated with at least one of the model level, the diagram level, or the project level.

25. The model repository system of claim 1, wherein at least one of the attributes is

5 automatically associated with each data model by the data mining application.

26. The model repository system of claim 1, wherein at least one of the attributes is manually associated with the data models by a user of the system.

10 27. The model repository system of claim 1, wherein the one or more index structures at least includes one index for storing one set of attributes and other indexes for storing other different sets of attributes.

28. The model repository system of claim 2, further comprising:

15 at least three configuration files stored in the model repository, wherein a first configuration file stores information that is used by the model repository facility in exporting the generated data models to the model repository, and second and third configuration files store information that is used by the model repository system in building the main index in the model repository from attributes supplied by human end users and from the data mining application.

20 29. The model repository system of claim 2, wherein the model repository facility builds the index structures stored in the model repository after one or more selected models have been exported to the model repository.

30. The model repository system of claim 1, further comprising:

a plurality of model repositories for storing the generated data models, wherein each of the plurality of model repositories includes one or more index structures containing a plurality of attributes that describe the data models stored in the respective model repository.

31. A data modeling method, comprising the steps of:

generating a plurality of data models using a data mining application;  
storing the plurality of data models in a database associated with the data mining application;  
selecting one or more of the plurality of data models;  
exporting the selected data models from the database to a model repository; and  
generating an index of the data models stored in the model repository wherein the index is based upon a plurality of attributes associated with the data models in the model repository.

32. The data modeling method of claim 31, further comprising the step of:

organizing the database into a plurality of project folders and storing the data models in the respective project folders within the database.

33. The data modeling method of claim 31, further comprising the step of:

searching the index and retrieving one or more of the data models stored in the model repository.

34. The data modeling method of claim 31, further comprising the step of:

providing a software mechanism for searching the index and retrieving one or more of the data models stored in the model repository.

5 35. The data modeling method of claim 34, further comprising the step of:

comparing the retrieved data models to determine which model is the most relevant.

36. The data modeling method of claim 31, further comprising the step of:

10 automatically associating one or more attributes with the data models when they are generated by the data mining application.

37. The data modeling method of claim 31, further comprising the step of:

15 manually associating one or more attributes with the selected data models before the exporting step.

38. The data modeling method of claim 31, wherein the generating one or more indexes step further includes the steps of:

generating a main index that includes attributes of all the models stored in the model repository; and

20 generating one or more special indexes that include attributes from a sub-set of all the models stored in the model repository.

39. The data modeling method of claim 31, further comprising the steps of:

organizing main-type index and tree-type index as attribute tables that include a plurality of rows and columns, wherein each row in the attribute table is associated with a particular data model, and wherein each column in the attribute table is associated with a particular attribute; and

5 organizing a mini-index as an attribute table that includes a plurality of rows and one column, wherein each row in the attribute table is associated with one attribute in the tree-type index.

40. The data modeling method of claim 31, further comprising the step of:

10 organizing the model repository into a plurality of storage levels.

41. The data modeling method of claim 31, wherein the exporting step further comprises the steps of:

specifying an address of the model repository;

15 determining whether a user who selected the one or more data models has write access to the model repository; and

if the user does have write access, then exporting the selected data models to the model repository identified by the address,

and if the user does not have write access, then notifying the user that the export

20 operation cannot be accomplished.

42. The data modeling method of claim 41, wherein the exporting step further comprises the steps of:

creating an export object;

initializing the export object;

querying a first configuration file in the model repository to determine what data from the selected data models is to be exported to the model repository;

5            querying second and third configuration files in the model repository to determine what data from the data models in the model repository is to build a main index in the model repository;

            configuring the export object based on the querying step; and

            invoking an export method on the export object; and

10           building the main index based on the querying of the second and third configuration files step.

43. The data modeling method of claim 31, further comprising the steps of:

            selecting one or more additional data models;

15           exporting the selected one or more additional data models from the database to the model repository; and

            regenerating the index.

44. The data modeling method of claim 31, further comprising the steps of:

20           generating one or more indexes of the data models stored in the model repository wherein the indexes are based upon a plurality of attributes associated with the data models in the model repository.

            selecting one or more additional data models;

exporting the selected one or more additional data models from the database to the model repository; and

regenerating the one or more indexes.

5 45. A data modeling method, comprising the steps of:

associating one or more attributes with each of a plurality of data models;

exporting the plurality of data models to a model repository;

generating one or more index structures comprising the one or more attributes of each of the data models in the model repository; and

10 providing a search mechanism and a retrieval mechanism for searching the one or more index structures in order to retrieve one or more data models from the model repository.

46. A computer-implemented model repository system for managing data models, comprising:

a model repository that stores the data models;

15 a data input module that processes attribute information descriptive of the data models;

and

at least one searchable index whose data structure contains storage locations for the attribute information;

said attributes in the index are searchable in order to locate at least one of the data

20 models.

47. The model repository system of claim 46 wherein the data input module includes a model repository facility that exports the data models to the model repository, said model repository



facility building the index structure stored in the model repository after one or more data models have been exported to the model repository.

48. The model repository system of claim 47, further comprising:

5       a first configuration file that stores information that is used by the model repository facility in exporting the data models to the model repository; and

      second and third configuration files that store information that is used by the model repository system in building a main index in the model repository from attributes supplied by human end users and from a data mining application.

49. The model repository system of claim 46 wherein the model repository system has a connection to a network and receives an index search request across the network.

50. The model repository system of claim 48 wherein the network is an Internet network.

51. The model repository system of claim 46, further comprising:

      a search and retrieval interface for searching the one or more index data structures in the model repository and for retrieving one or more of the data models based on the searching by the search and retrieval interface.

52. The model repository system of claim 46, further comprising:

      a project folder store associated with a data mining application for temporary storage of data models generated by a data mining application.

53. The model repository system of claim 46 further comprising:

a software application that includes a comparison algorithm for determining which of the data models is the most relevant model.

5

54. The model repository system of claim 46, wherein the one or more index structures include a main index and one or more special indexes, wherein the main index includes attributes of the data models stored in the model repository, and the one or more special indexes include attributes from a sub-set of the data models stored in the model repository.

55. The model repository system of claim 54, wherein the one or more special indexes include a tree-type index for storing attributes associated with data models that are generated using a decision tree algorithm.

56. The model repository system of claim 55, further comprising:

a mini-index associated with the tree-type index for storing a sub-set of the attributes stored in the tree-type index.

57. The model repository system of claim 56, wherein the attributes stored in the tree-type index include a plurality of splitting variables associated with the decision tree algorithm.

58. The model repository system of claim 46, wherein the model repository is organized into a plurality of storage levels.

59. The model repository system of claim 58, wherein the plurality of storage levels include a project level, a diagram level, and a model level.

60. The model repository system of claim 59, wherein a particular data model is stored in the model repository at the model level.

61. The model repository system of claim 60, wherein each model stored at the model level is associated with a particular diagram stored at the diagram level.

62. The model repository system of claim 61, wherein each diagram stored at the diagram level includes a set of specifications for operating a data mining application.

63. The model repository system of claim 62, wherein each diagram stored at the diagram level is associated with a particular project folder stored at the project level.

64. The model repository system of claim 59, wherein the attributes of the data models are associated with at least one of the model level, the diagram level, or the project level.

65. The model repository system of claim 46, further comprising:

a plurality of model repositories for storing the data models, wherein each of the plurality of model repositories includes one or more index structures containing a plurality of attributes that describe the data models stored in the respective model repository.

66. The model repository system of claim 46, further comprising:

group-specific indexes for storing group-specific attributes to search the data models in the model repository.

5

67. The model repository system of claim 65 wherein the group-specific indexes are indexes selected from the group consisting of a marketing-specific index for storing marketing-related attributes to search the data models in the model repository, sales-specific indexes for storing sales-related attributes to search the data models in the model repository, and combinations thereof.

## ABSTRACT

A model repository is provided for storing selected data models generated by a data mining application. The model repository is a structure that may be organized into a plurality of levels, including a project level, a diagram level, and a model level. The project level may include one or more diagrams, each of which describes a particular set of model specifications. Each diagram may then be associated with one or more models. Associated with the model repository is a model repository facility that is preferably integrated into the data mining application and enables operations, such as the exportation of useful models to the model repository. The model repository may also include one or more index data structures for storing attributes of the models within the model repository. These indexes may include a main index that contains attributes of all the models stored in the model repository, and one or more special indexes, such as a tree-type index and mini-index, that contain the attributes of a particular sub-set of the models stored in the model repository. A user may then search through the one or more indexes in order to find a model that suits his or her needs. Alternatively, a user application program may programmatically query the model repository in order to find and extract information from a particular model stored in the model repository.

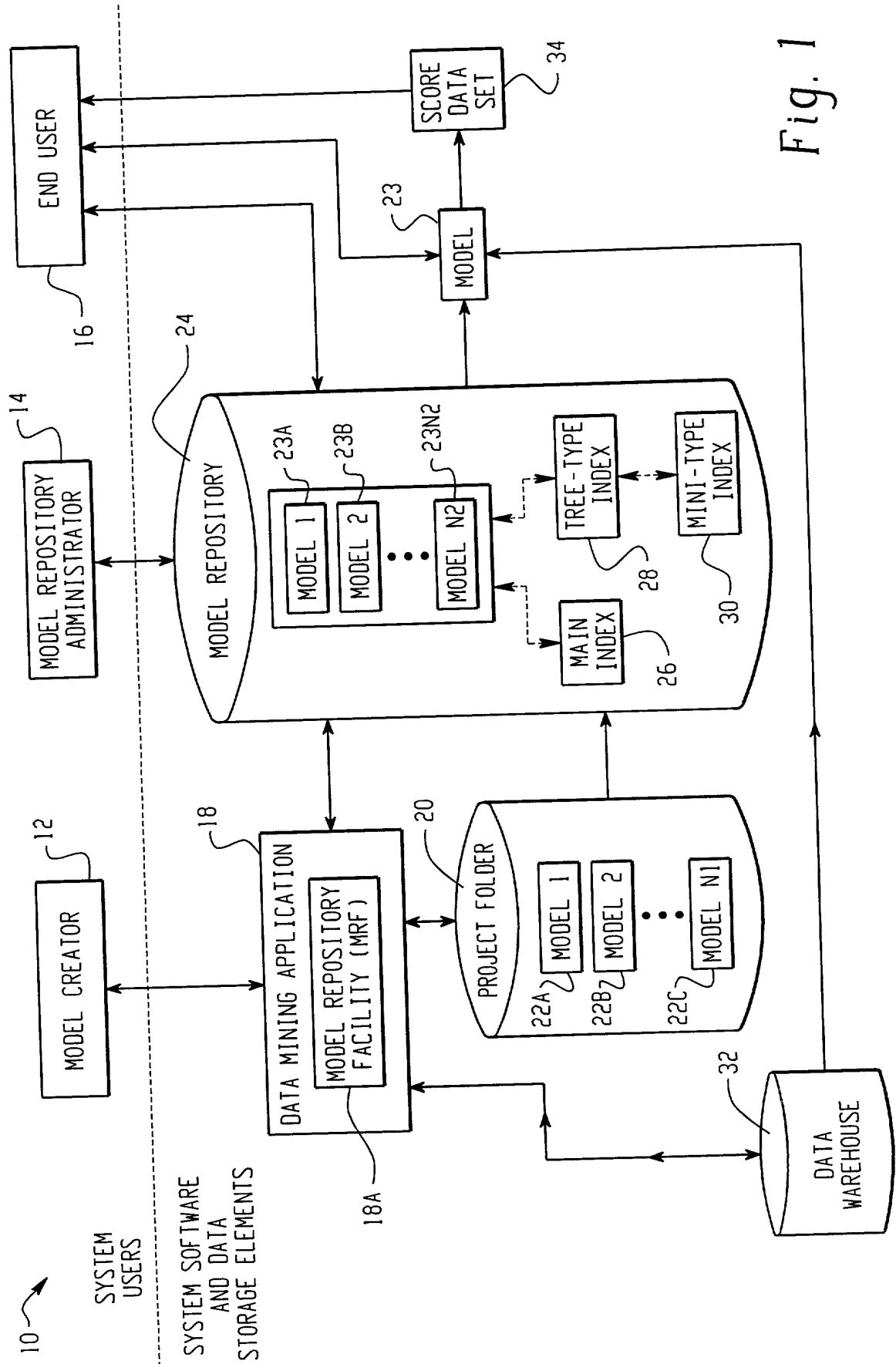


Fig. 1

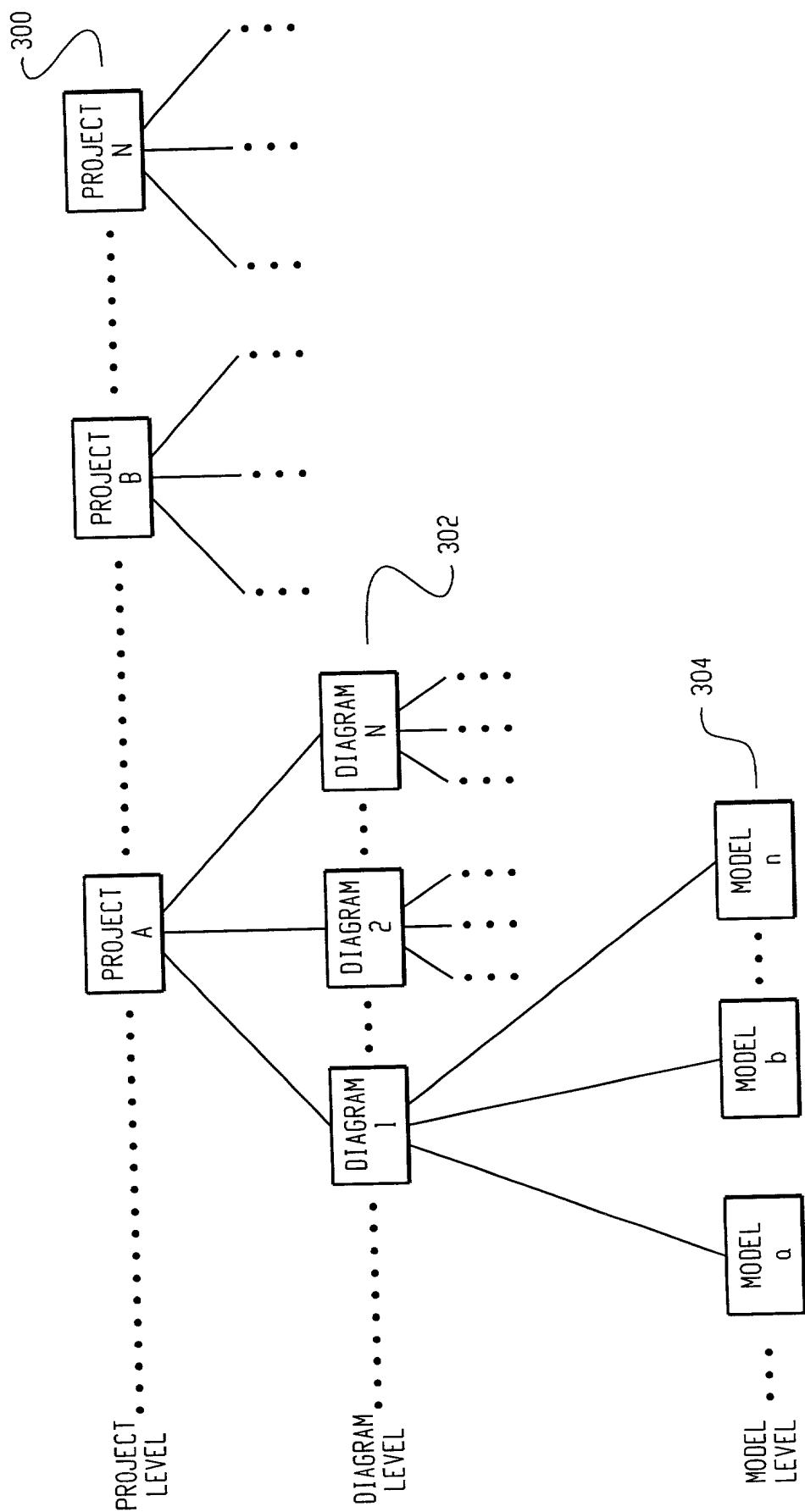


Fig. 2

Fig. 3

26	40	42A	42B	42N
MODEL'S FOLDER NAME	ATTRIBUTE A1	ATTRIBUTE A2	ATTRIBUTE A3	ATTRIBUTE M1
000_A000072_MODEL	VALUE	VALUE	...	VALUE
002_A0000XH_MODEL	VALUE	VALUE	...	VALUE
001_A0000FD_MODEL	VALUE	VALUE	...	VALUE
...	...	...	...	...

Fig. 4

28A	50	52A	52B	52C	52N
MODEL'S FOLDER NAME	SPLITTING VARIABLE SV1's NAME	SPLITTING VARIABLE SV2's NAME	SPLITTING VARIABLE SV3's NAME	SPLITTING VARIABLE M2's NAME	
000_A000072_MODEL	Y	N	Y	...	N
001_A0000FD_MODEL	N	N	N	...	N
...	...	...	...	...	...

Fig. 5

28B	60	62
MODEL'S FOLDER NAME	SPLITTING VARIABLE'S NAME	
000_A000072_MODEL	SPLITTING-VARIABLE-SV1's NAME	
000_A000072_MODEL	SPLITTING-VARIABLE-SV3's NAME	
000_A000072_MODEL	SPLITTING-VARIABLE-SV6's NAME	
000_A000072_MODEL	SPLITTING-VARIABLE-SV13's NAME	
001_A0000FD_MODEL	SPLITTING-VARIABLE-SV6's NAME	
001_A0000FD_MODEL	SPLITTING-VARIABLE-SV16's NAME	
...	...	...



30

SPLITTING VARIABLE'S NAME
SPLITTING-VARIABLE-SV1'S NAME
SPLITTING-VARIABLE-SV2'S NAME
⋮

*Fig. 6*

```
graph TD; 100((START)) --> 101[USER CREATES DATA MINING MODELS WITH DATA MINING APPLICATION]; 101 --> 102[USER ADDS MODEL DESCRIPTIONS AT PROJECT, DIAGRAM, AND/OR MODEL LEVELS]; 102 --> 104[USER COMPARES MODELS]; 104 --> 106((A)); 106 --> 106[USER SELECTS A MODEL FOR EXPORTING TO MODEL REPOSITORY]; 106 --> 108[USER SPECIFIES THE PATHNAME OF THE MODEL REPOSITORY]; 108 --> 110[USER CLICKS ON THE EXPORT BUTTON]; 110 --> 108;
```

FIG. 7A

100 START

101 USER CREATES DATA MINING MODELS WITH DATA MINING APPLICATION

102 USER ADDS MODEL DESCRIPTIONS AT PROJECT, DIAGRAM, AND/OR MODEL LEVELS

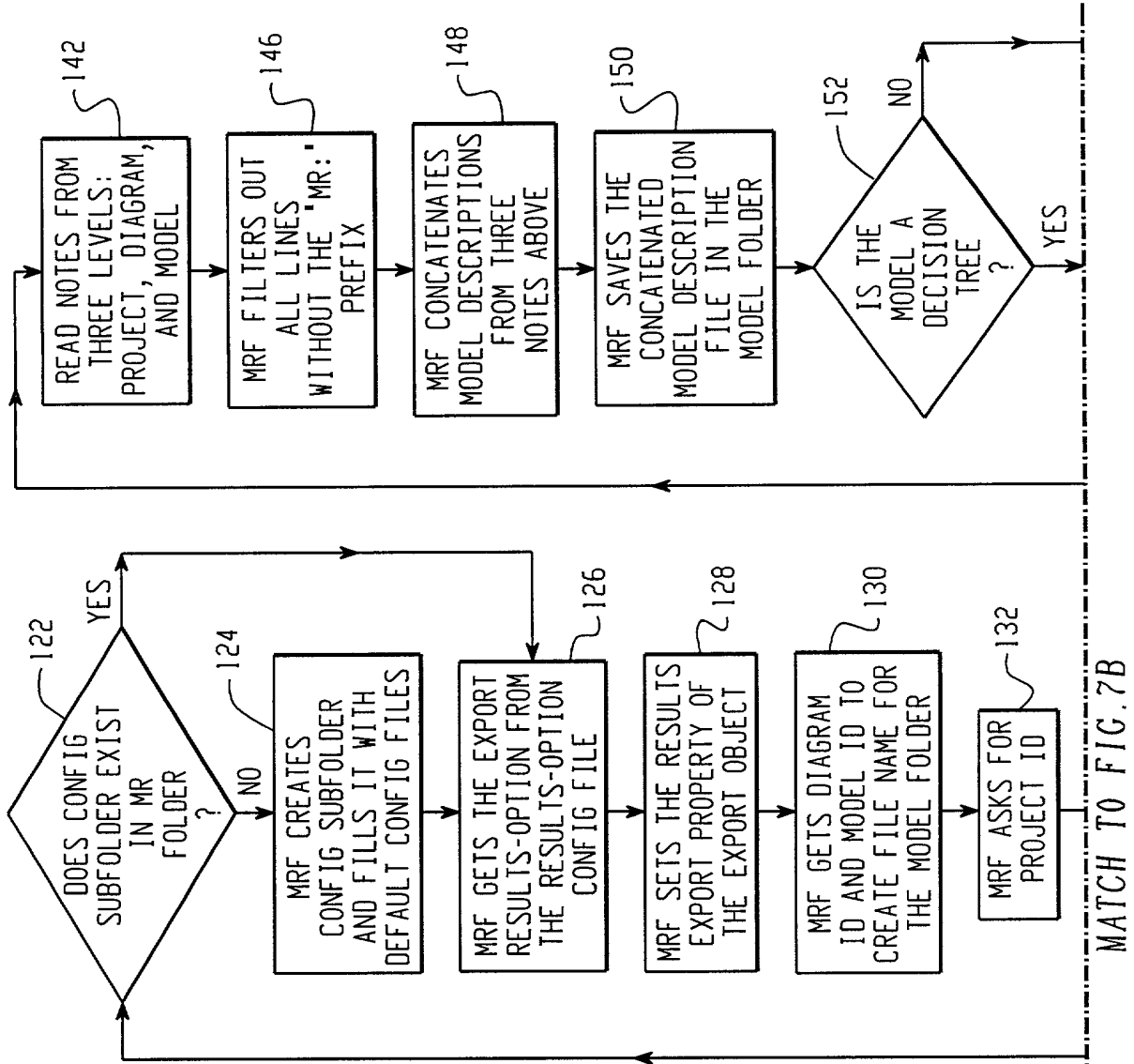
104 USER COMPARES MODELS

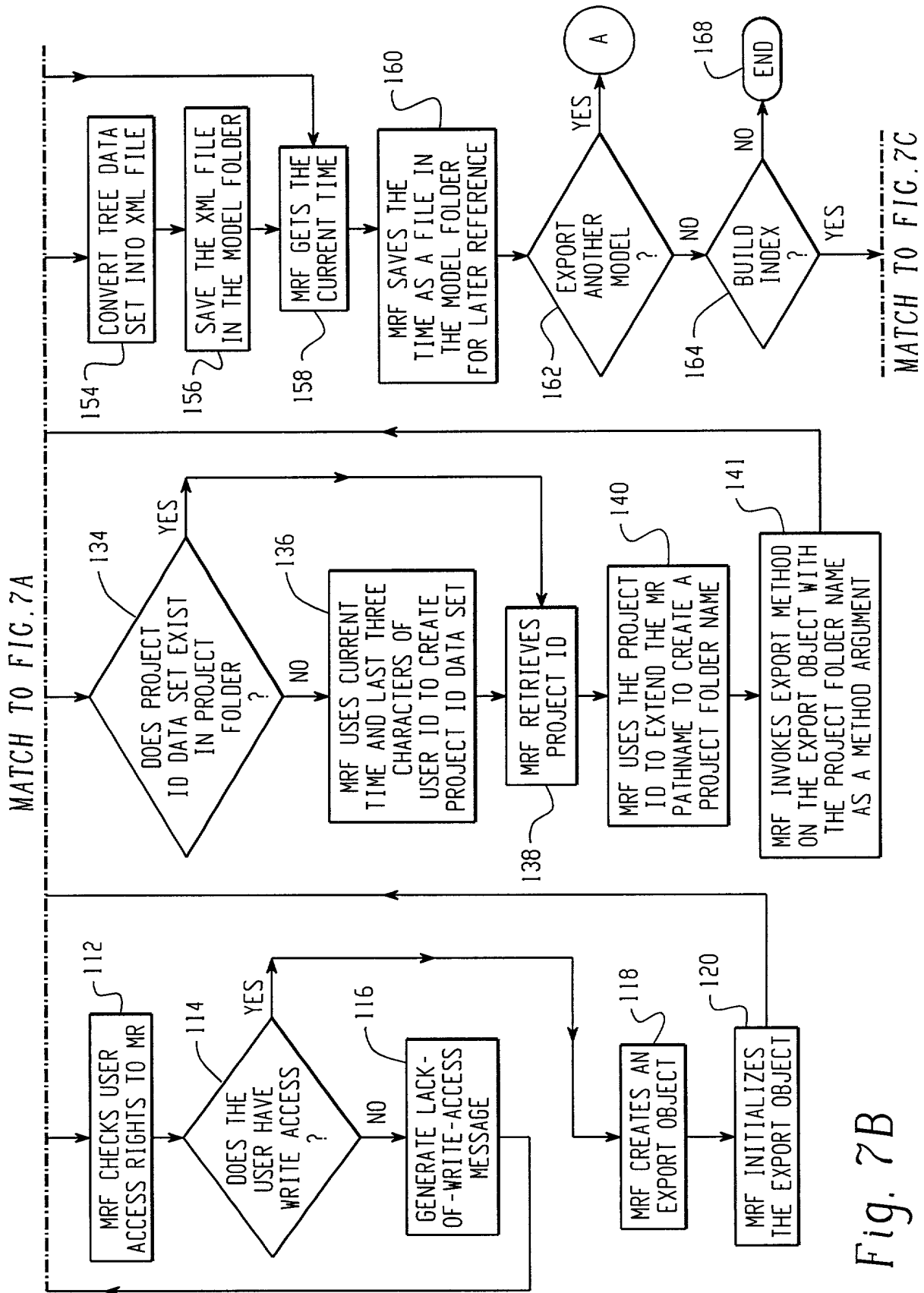
A

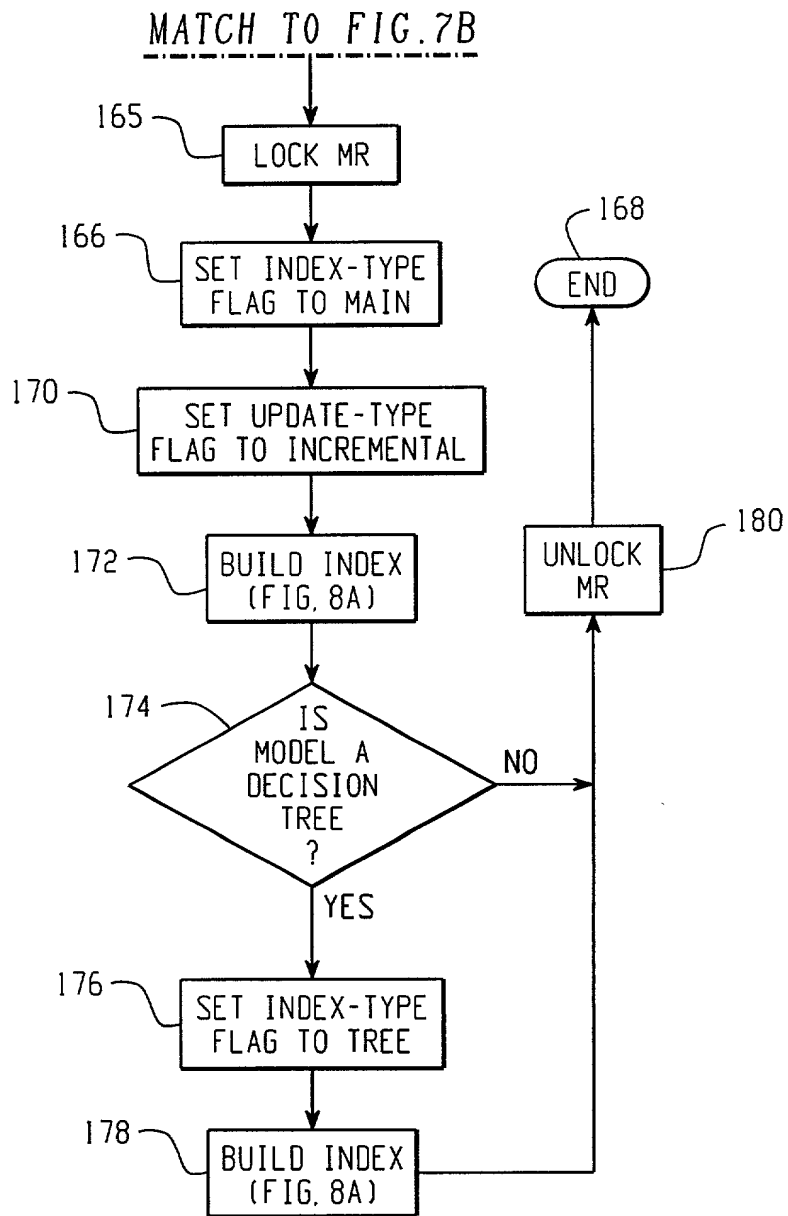
106 USER SELECTS A MODEL FOR EXPORTING TO MODEL REPOSITORY

108 USER SPECIFIES THE PATHNAME OF THE MODEL REPOSITORY

110 USER CLICKS ON THE EXPORT BUTTON





*Fig. 7C*

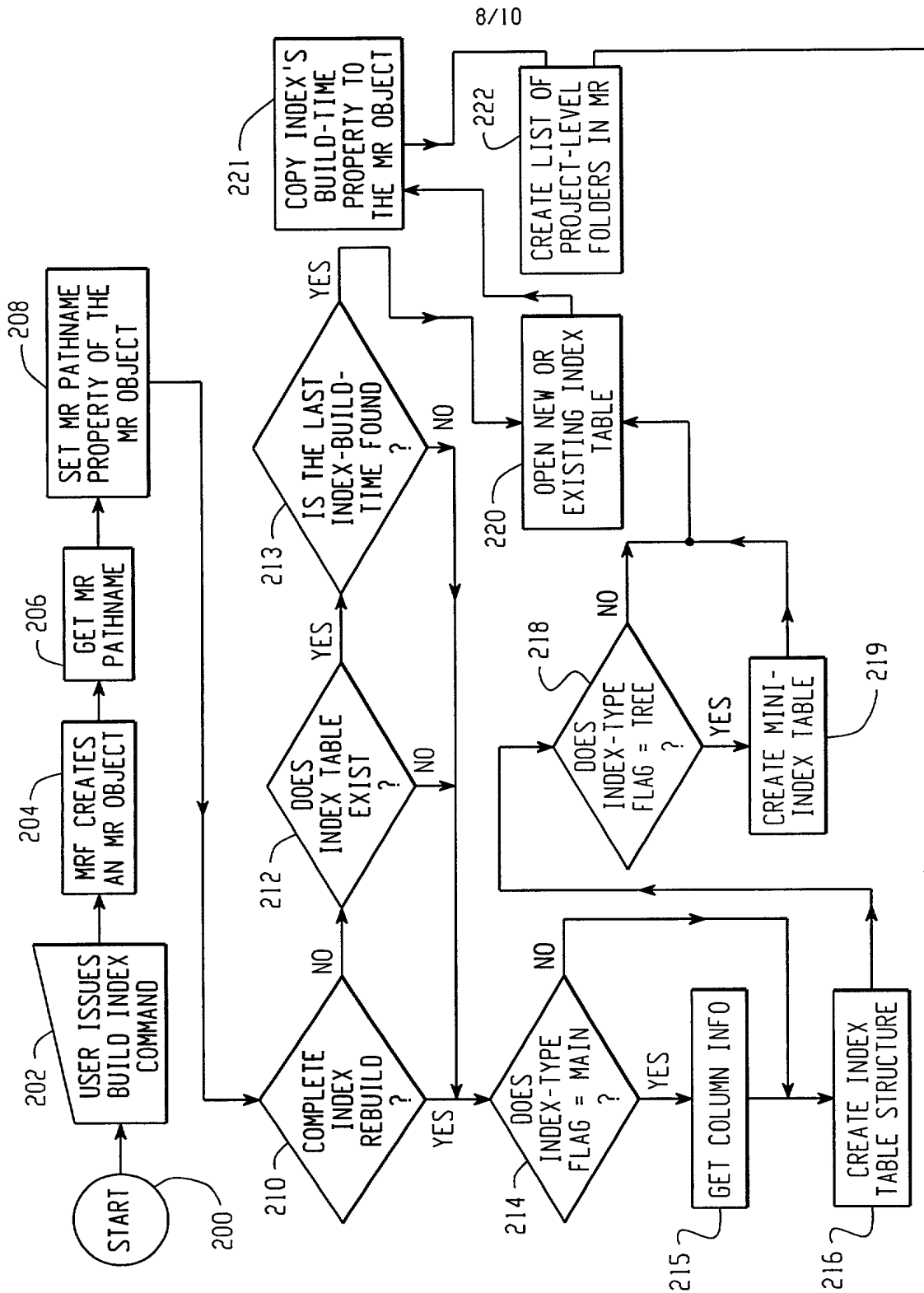


Fig. 8A

MATCH TO FIG. 8B

MATCH TO FIG. 8A

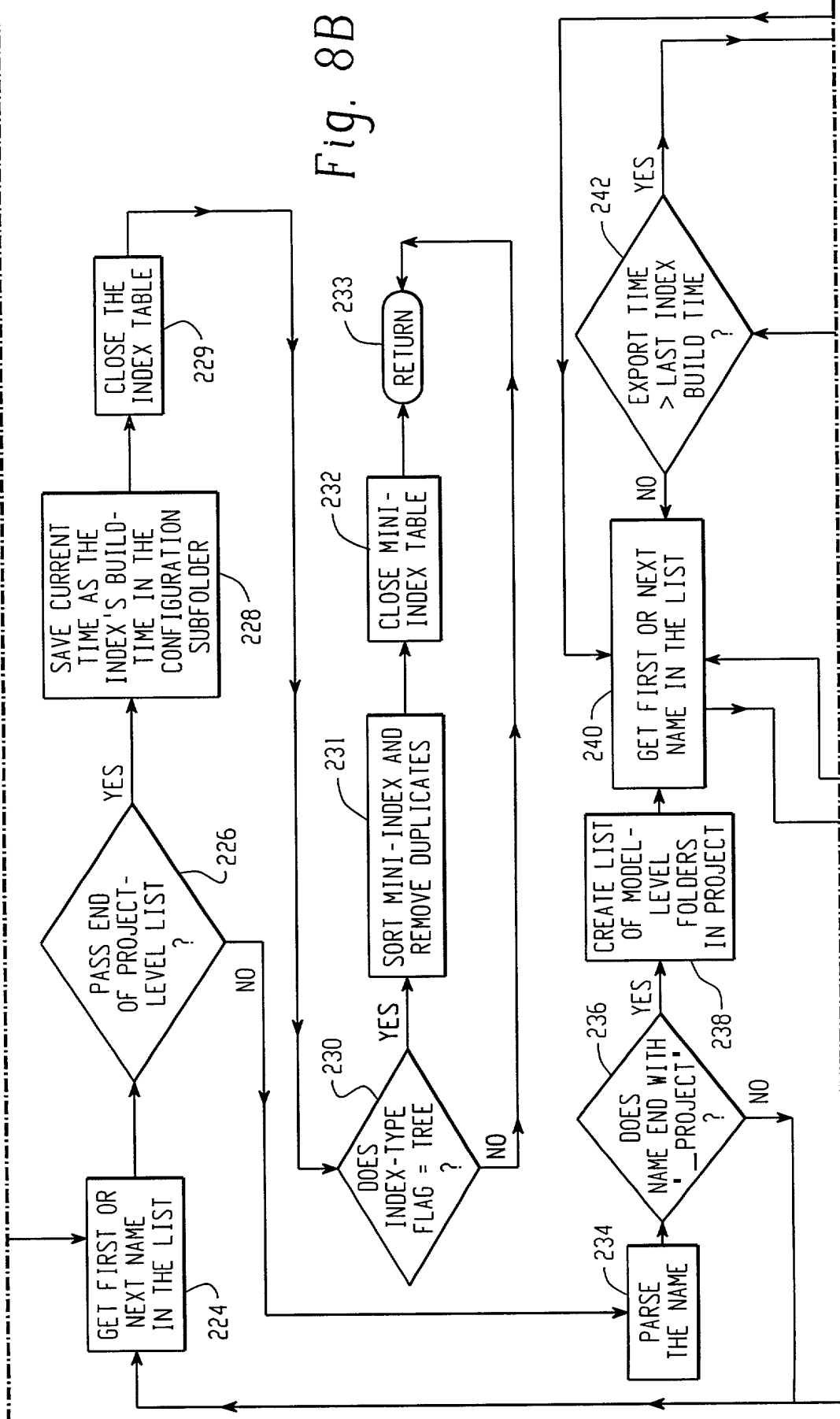


Fig. 8B

MATCH TO FIG. 8C

MATCH TO FIG. 8B

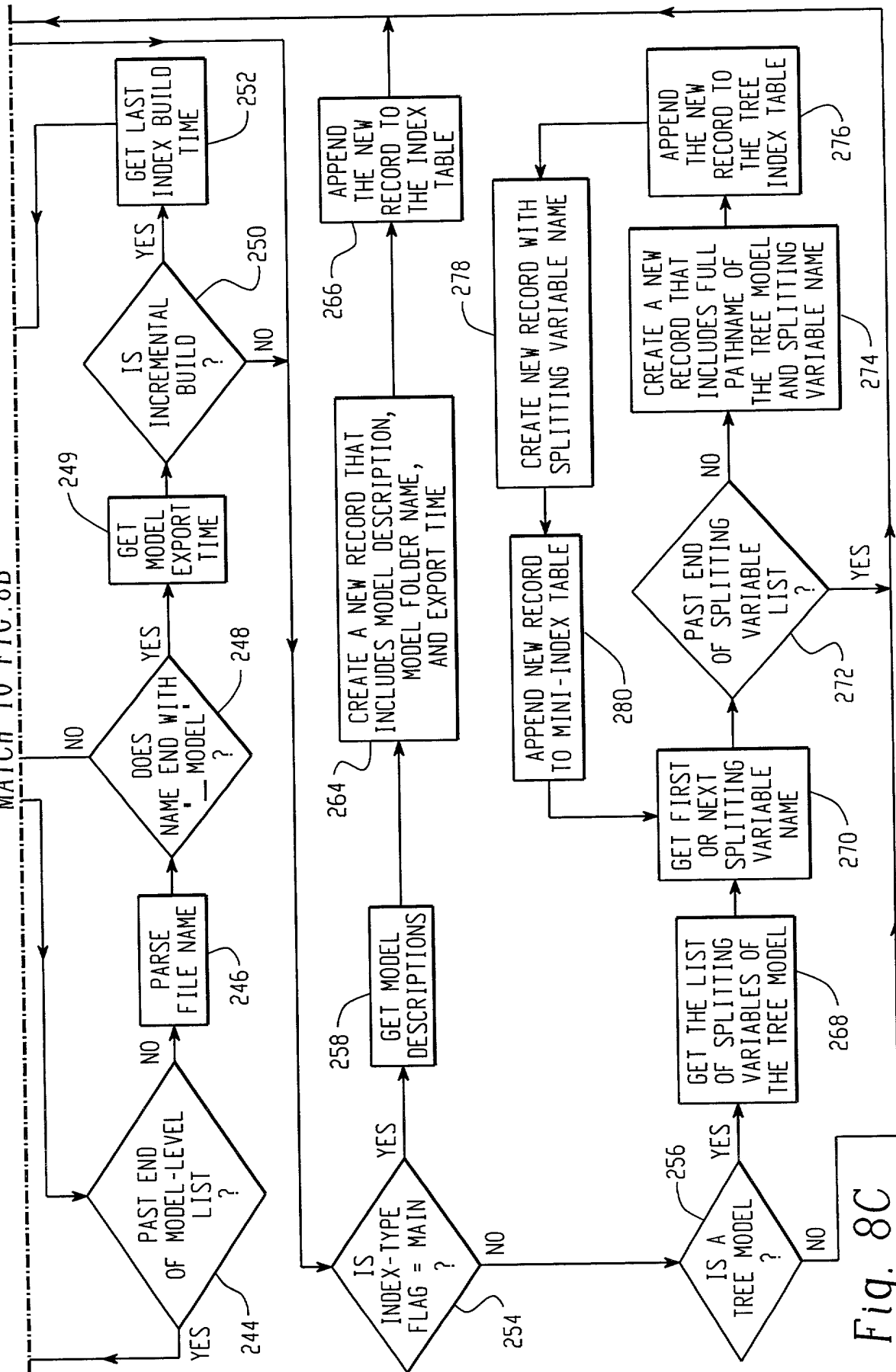


Fig. 8C